

[0318] What is claimed is:

1 1. A computer-implemented method of discovering relationships between  
2 items, comprising:  
3 accepting item selections from a plurality of users;  
4 generating a log for each user, each log containing identifiers for the user's  
5 item selections;  
6 accepting a query including at least one query item identifier;  
7 scoring the user logs, responsive to a degree of occurrence of the at least  
8 one query item identifier in the user logs, to generate user log  
9 scores; and  
10 determining at least one result item, responsive to a degree of occurrence  
11 in at least a subset of the scored user logs.

1 2. The computer-implemented method of claim 1, wherein a significance  
2 of the occurrence is determined by a log likelihood ratio analysis and the deter-  
3 mined result is responsive to the determined significance.

1 3. The computer-implemented method of claim 1, wherein a significance  
2 of the occurrence is determined by a substantial equivalent of a log likelihood  
3 ratio analysis and the determined result is responsive to the determined signifi-  
4 cance.

1           4. The computer-implemented method of claim 1, wherein each item is a  
2 video track and wherein accepting item selections comprises determining which  
3 tracks are selected for playback.

1           5. The computer-implemented method of claim 1, wherein each item is a  
2 music track and wherein accepting item selections comprises determining which  
3 tracks are selected for playback.

1           6. The computer-implemented method of claim 5, further comprising:  
2 generating a track list containing an identifier for each determined result  
3 item comprising a music track.

1           7. The computer-implemented method of claim 6, further comprising:  
2 deleting from the track list at least one identifier corresponding to a music  
3 track already selected by the user.

1           8. The computer-implemented method of claim 6, further comprising:  
2 playing the music tracks specified by the generated track list.

1           9. The computer-implemented method of claim 5, further comprising:  
2 accepting a format schedule specifying music track categories for time pe-  
3 riods; and

4 generating a track list conforming to the format schedule and containing  
5 an identifier for each determined result item comprising a music  
6 track.

1 10. The computer-implemented method of claim 5, wherein scoring the  
2 user logs comprises determining a degree of occurrence in each user log of at  
3 least one music track identified by the query item identifier.

1 11. The computer-implemented method of claim 5, wherein scoring the  
2 user logs comprises determining a degree of occurrence in each user log of at  
3 least one music track associated with an artist identified by the query item identi-  
4 fier.

1 12. The computer-implemented method of claim 1, wherein accepting item  
2 selections comprises receiving input provided by a user via a web page.

1 13. The computer-implemented method of claim 1, wherein accepting item  
2 selections comprises receiving input specifying an item purchase by a user.

1 14. The computer-implemented method of claim 1, further comprising,  
2 prior to determining the at least one result item, defining the subset of the scored  
3 user logs responsive to the user log scores.

1 15. The computer-implemented method of claim 1, further comprising:  
2 monitoring user behavior with respect to the selected items; and  
3 adjusting the user log responsive to the monitored user behavior.

1 16. The computer-implemented method of claim 15, wherein monitoring  
2 user behavior comprises at least one selected from the group consisting of:  
3 detecting user input requesting that a selected item be repeated;  
4 detecting user input requesting that a selected item be skipped;  
5 detecting user input specifying a volume change; and  
6 detecting user input specifying that a selected item be muted.

1 17. The computer-implemented method of claim 1, wherein accepting item  
2 selections comprises receiving input provided by a user via an application for  
3 playing tracks.

1 18. The computer-implemented method of claim 1, wherein accepting a  
2 query comprises receiving a user log containing identifiers for a user's item selec-  
3 tions.

1 19. The computer-implemented method of claim 1, wherein accepting a  
2 query comprises receiving a first search term, the method further comprising:

3 generating a second search term containing an identifier for each deter-  
4 mined result item.

1 20. The computer-implemented method of claim 19, further comprising at  
2 least one of:

3 providing the second search term as input for a search engine; and  
4 adding the second search term to a searchable portion of a document as-  
5 sociated with the first search term.

1 21. The computer-implemented method of claim 1, further comprising:  
2 periodically uploading the generated log.

1 22. The computer-implemented method of claim 1, further comprising:  
2 outputting an advertisement relating to the determined at least one result  
3 item.

1 23. The computer-implemented method of claim 22, wherein outputting  
2 an advertisement comprises displaying at least one selected from the group con-  
3 sisting of:

4 a web page;  
5 a banner;  
6 a portion of a web page; and  
7 an animation.

1           24. The computer-implemented method of claim 1, further comprising:  
2           outputting a notification relating to the determined at least one result  
3           item.

1           25. The computer-implemented method of claim 24, wherein outputting a  
2           notification comprises displaying a web page.

1           26. The computer-implemented method of claim 24, wherein outputting a  
2           notification comprises sending a communication to a user.

1           27. The computer-implemented method of claim 26, wherein sending a  
2           communication to a user comprises at least one selected from the group consist-  
3           ing of:

4           transmitting an electronic mail message to the user;  
5           telephoning the user; and  
6           sending a direct mail item to the user.

1           28. The computer-implemented method of claim 1, wherein the deter-  
2           mined result is responsive to a significance of the occurrence of the item in at  
3           least a subset of the scored user logs, and wherein the significance is determined  
4           by a log likelihood ratio analysis submethod comprising:  
5           determining a total number of user logs N;

6 determining a number of user logs  $N_1$  in a subset of user logs;  
 7 determining a number of user logs  $N_2$  not in the subset of user logs;  
 8 determining a number of user logs  $k_{11}$  in the subset that include the item;  
 9 determining a number of user logs  $k_{12}$  not in the subset that include the  
 10 item;  
 11 determining a number of user logs  $k_{21} = N_1 - k_{11}$  in the subset that do not  
 12 include the item;  
 13 determining a number of user logs  $k_{22} = N_2 - k_{12}$  not in the subset that do  
 14 not include the item;  
 15 and determining a log likelihood ratio for the item.

1 29. The computer-implemented method of claim 28, wherein the log like-  
 2 lihood ratio is defined as:

$$\sum k_{ij} \log \frac{\pi_{ij}}{\mu_j}$$

4 where:  $\pi_{ij} = \frac{k_{ij}}{N_j}$ ,  $\mu_j = \sum_i \frac{k_{ij}}{N}$ .

1 30. The computer-implemented method of claim 29, further comprising:  
 2 adjusting at least one of the  $k_{ij}$  values responsive to at least one selected  
 3 from the group consisting of:  
 4 the number of occurrences of the item in a user log;

5 the logarithm of the number of occurrences of the item in a user  
6 log;  
7 the number of occurrences of the item in all user logs;  
8 the logarithm of the total number of users divided by the number  
9 of users who have selected the item; and  
10 a normalizing factor.

1 31. The computer-implemented method of claim 30, wherein the normal-  
2 izing factor is  $\frac{1}{\sqrt{\sum (S_j W_{ij})^2}}$ , where  $S_j$  is a weight based on the number of occur-  
3 rences of the item in all user logs and  $W_{ij}$  is a weight based on the number of oc-  
4 currences of the item in a particular user log.

1 32. The computer-implemented method of claim 1, further comprising:  
2 deleting from the determined at least one result item any result items al-  
3 ready selected by a user associated with the query.

1 33. The computer-implemented method of claim 1, further comprising:  
2 ranking the at least one result item responsive to the degree of signifi-  
3 cance.

1 34. A computer-implemented method of discovering a relationship be-  
2 tween a first item and a second item, comprising:





36. The computer-implemented method of claim 35, wherein each item group comprises a document.

37. The computer-implemented method of claim 35, further comprising:  
adjusting at least one of the  $k_{ij}$  values responsive to at least one selected  
from the group consisting of:  
the number of occurrences of the item in a document;  
the logarithm of the number of occurrences of the item in a document;  
the number of occurrences of the item in all documents;  
the logarithm of the total number of documents divided by the  
number of documents that include the item; and  
a normalizing factor.

38. The computer-implemented method of claim 37, wherein the normalizing factor is  $\frac{1}{\sqrt{\sum (S_j W_{ij})^2}}$ , where  $S_j$  represents the number of occurrences of the item in all documents and  $W_{ij}$  represents the number of occurrences of the item in a particular document.

39. A system for discovering relationships among items, comprising:  
a user interface for accepting item selections from a plurality of users;

at least one log database, coupled to the user interface, for storing a log for  
each user, each log containing identifiers for the user's item  
selections;  
a query input device for accepting a query including at least one query  
item identifier; and  
a recommendation engine, coupled to the log database and to the query  
input device, for scoring the user logs, responsive to a degree of  
occurrence, to generate user log scores, and for determining at  
least one result item, responsive to a degree of occurrence in at  
least a subset of the scored user logs.

40. The system of claim 39, wherein the significance of the occurrence is  
determined by a log likelihood ratio analysis and the recommendation engine  
determines the at least one result item responsive to the determined significance.

41. The system of claim 39, wherein the significance of the occurrence is  
determined by a substantial equivalent of a log likelihood ratio analysis and  
wherein the recommendation engine determines the at least one result item re-  
sponsive to the determined significance.

1           42. The system of claim 39, wherein each item is a video track and wherein  
2     the user interface accepts item selections by determining which tracks are se-  
3     lected for playback.

1           43. The system of claim 39, wherein the user interface accepts item selec-  
2     tions by determining which tracks are selected for purchase.

1           44. The system of claim 39, wherein each item is a music track and  
2     wherein the user interface accepts item selections by determining which tracks  
3     are selected for playback.

1           45. The system of claim 44, wherein the user interface comprises an online  
2     jukebox.

1           46. The system of claim 45, wherein the online jukebox monitors user be-  
2     havior with respect to the selected items and adjusts the user log scores respon-  
3     sive to the monitored user behavior.

1           47. The system of claim 46, wherein the online jukebox monitors user be-  
2     havior by detecting at least one selected from the group consisting of:  
3     user input requesting that a selected item be repeated; and  
4     user input requesting that a selected item be skipped; and

5 user input specifying a volume change; and  
 6 user input specifying that a selected item be muted.

1 48. The system of claim 47, further comprising:  
 2 a track list generator, coupled to the recommendation engine, for generat-  
 3 ing a track list containing an identifier for each determined re-  
 4 sult item comprising a music track.

1 49. The system of claim 44, further comprising:  
 2 a music player, coupled to the track list generator, for playing the music  
 3 tracks specified by the generated track list.

1 50. The system of claim 44, further comprising:  
 2 a format scheduler, for accepting a format schedule specifying music track  
 3 categories for time periods; and  
 4 a track list generator, coupled to the recommendation engine and to the  
 5 format scheduler, for generating a track list conforming to the  
 6 format schedule and containing an identifier for each deter-  
 7 mined result item comprising a music track.

1 51. The system of claim 39, wherein the query input device receives a user  
 2 log containing identifiers for a user's item selections.

1           52. The system of claim 39, wherein the query input device receives a first  
2 search term, the system further comprising:  
3           a search term generator, coupled to the recommendation engine, for gen-  
4           erating a second search term containing an identifier for each  
5           determined result item and for providing the second search  
6           term as input for a search engine.

1           53. The system of claim 39, wherein the query input device receives a first  
2 search term, the system further comprising:  
3           a search term generator, coupled to the recommendation engine, for gen-  
4           erating a second search term containing an identifier for each  
5           determined result item and for providing the second search  
6           term to be added to a searchable portion of a document associ-  
7           ated with the first search term.

1           54. The system of claim 39, further comprising:  
2           an advertisement output device, coupled to the recommendation engine,  
3           for outputting an advertisement relating to the determined at  
4           least one result item.

1           55. The system of claim 54, wherein the advertisement output device dis-  
2 plays at least one selected from the group consisting of:

3 a web page;  
4 a banner;  
5 a portion of a web page; and  
6 an animation.

1 56. The system of claim 39, further comprising:  
2 a notification output, coupled to the recommendation engine, for output-  
3 ting a notification relating to the determined at least one result  
4 item.

1 57. The system of claim 56, wherein the notification output device displays  
2 at least one selected from the group consisting of:  
3 a web page;  
4 a banner;  
5 a portion of a web page; and  
6 an animation.

1 58. The system of claim 56, wherein the notification output device sends a  
2 communication to a user.

1 59. A computer-readable medium comprising computer-readable code for  
2 discovering relationships between items, comprising:

3 computer-readable code adapted to accept item selections from a plurality  
4 of users;  
5 computer-readable code adapted to generate a log for each user, each log  
6 containing identifiers for the user's item selections;  
7 computer-readable code adapted to accept a query including at least one  
8 query item identifier;  
9 computer-readable code adapted to score the user logs, responsive to a  
10 degree of occurrence of the at least one query item identifier in  
11 the user logs, to generate user log scores; and  
12 computer-readable code adapted to determine at least one result item, re-  
13 sponsive to a degree of occurrence in at least a subset of the  
14 scored user logs.

1 60. The computer-readable medium of claim 59, wherein a significance of  
2 the occurrence is determined by a log likelihood ratio analysis and the deter-  
3 mined result is responsive to the determined significance.

1 61. The computer-readable medium of claim 59, wherein a significance of  
2 the occurrence is determined by a substantial equivalent of a log likelihood ratio  
3 analysis and the determined result is responsive to the determined significance.



1           62. The computer-readable medium of claim 59, wherein each item is a  
2 video track and wherein the computer-readable code adapted to accept item se-  
3 lections comprises computer-readable code adapted to determine which tracks  
4 are selected for playback.

1           63. The computer-readable medium of claim 59, wherein each item is a  
2 music track and wherein the computer-readable code adapted to accept item se-  
3 lections comprises computer-readable code adapted to determine which tracks  
4 are selected for playback.

1           64. The computer-readable medium of claim 63, further comprising:  
2 computer-readable code adapted to generate a track list containing an  
3 identifier for each determined result item comprising a music  
4 track.

1           65. The computer-readable medium of claim 64, further comprising:  
2 computer-readable code adapted to delete from the track list at least one  
3 identifier corresponding to a music track already selected by the  
4 user.

1           66. The computer-readable medium of claim 64, further comprising:

computer-readable code adapted to play the music tracks specified by the  
generated track list.

67. The computer-readable medium of claim 63, further comprising:  
computer-readable code adapted to accept a format schedule specifying  
music track categories for time periods; and  
computer-readable code adapted to generate a track list conforming to the  
format schedule and containing an identifier for each deter-  
mined result item comprising a music track.

68. The computer-readable medium of claim 63, wherein the computer-  
readable code adapted to score the user logs comprises computer-readable code  
adapted to determine a degree of occurrence in each user log of at least one mu-  
sic track identified by the query item identifier.

69. The computer-readable medium of claim 63, wherein the computer-  
readable code adapted to score the user logs comprises computer-readable code  
adapted to determine a degree of occurrence in each user log of at least one mu-  
sic track associated with an artist identified by the query item identifier.

70. The computer-readable medium of claim 59, wherein the computer-  
readable code adapted to accept item selections comprises computer-readable  
code adapted to receive input provided by a user via a web page.

1           71. The computer-readable medium of claim 59, wherein the computer-  
2     readable code adapted to accept item selections comprises computer-readable  
3     code adapted to receive input specifying an item purchase by a user.

1           72. The computer-readable medium of claim 59, further comprising, com-  
2     puter-readable code adapted to, prior to determine the at least one result item,  
3     define the subset of the scored user logs responsive to the user log scores.

1           73. The computer-readable medium of claim 59, further comprising:  
2     computer-readable code adapted to monitor user behavior with respect to  
3                 the selected items; and  
4     computer-readable code adapted to adjust the user log scores responsive  
5                 to the monitored user behavior.

1           74. The computer-readable medium of claim 73, wherein the computer-  
2     readable code adapted to monitor user behavior comprises at least one selected  
3     from the group consisting of:  
4     computer-readable code adapted to detect user input requesting that a se-  
5                 lected item be repeated;  
6     computer-readable code adapted to detect user input requesting that a se-  
7                 lected item be skipped;

8 computer-readable code adapted to detect user input specifying a volume  
9 change; and  
10 computer-readable code adapted to detect user input specifying that a se-  
11 lected item be muted.

1 75. The computer-readable medium of claim 59, wherein the computer-  
2 readable code adapted to accept item selections comprises computer-readable  
3 code adapted to receive input provided by a user via an application for playing  
4 tracks.

1 76. The computer-readable medium of claim 59, wherein the computer-  
2 readable code adapted to accept a query comprises computer-readable code  
3 adapted to receive a user log containing identifiers for a user's item selections.

1 77. The computer-readable medium of claim 59, wherein the computer-  
2 readable code adapted to accept a query comprises computer-readable code  
3 adapted to receive a first search term, the computer-readable medium further  
4 comprising:

5 computer-readable code adapted to generate a second search term con-  
6 taining an identifier for each determined result item.

1 78. The computer-readable medium of claim 77, further comprising at  
2 least one of:

3 computer-readable code adapted to provide the second search term as in-  
4 put for a search engine; and  
5 computer-readable code adapted to add the second search term to a  
6 searchable portion of a document associated with the first  
7 search term.

1 79. The computer-readable medium of claim 59, further comprising:  
2 computer-readable code adapted to periodically upload the generated log.

1 80. The computer-readable medium of claim 59, further comprising:  
2 computer-readable code adapted to output an advertisement relating to  
3 the determined at least one result item.

1 81. The computer-readable medium of claim 80, wherein the computer-  
2 readable code adapted to output an advertisement comprises computer-readable  
3 code adapted to display at least one selected from the group consisting of:

4 a web page;  
5 a banner;  
6 a portion of a web page; and  
7 an animation.

1 82. The computer-readable medium of claim 59, further comprising:

2 computer-readable code adapted to output a notification relating to the  
3 determined at least one result item.

1 83. The computer-readable medium of claim 82, wherein the computer-  
2 readable code adapted to output a notification comprises computer-readable  
3 code adapted to display a web page.

1 84. The computer-readable medium of claim 82, wherein the computer-  
2 readable code adapted to output a notification comprises computer-readable  
3 code adapted to send a communication to a user.

1 85. The computer-readable medium of claim 84, wherein the computer-  
2 readable code adapted to send a communication to a user comprises at least one  
3 selected from the group consisting of:

4 computer-readable code adapted to transmit an electronic mail message to  
5 the user;

6 computer-readable code adapted to telephone the user; and

7 computer-readable code adapted to send a direct mail item to the user.

1 86. The computer-readable medium of claim 59, wherein the determined  
2 result is responsive to a significance of the occurrence of the item in at least a  
3 subset of the scored user logs, and wherein the computer-readable code adapted  
4 to determine a binomial log likelihood ratio for an item comprises computer-

5 readable code adapted to determine the result by a log likelihood ratio analysis  
6 submethod.

1 87. The computer-readable medium of claim 86, wherein the computer-  
2 readable code adapted to determine the result by a log likelihood ratio analysis  
3 submethod comprises:

4 computer-readable code adapted to determine a total number of users  $N$ ;  
5 computer-readable code adapted to determine a number of users  $N_1$  in a  
6 subset of users;  
7 computer-readable code adapted to determine a number of users  $N_2$  not in  
8 the subset of users;  
9 computer-readable code adapted to determine a number of users  $k_{11}$  in the  
10 subset that selected the item;  
11 computer-readable code adapted to determine a number of users  $k_{12}$  not  
12 in the subset that selected the item;  
13 computer-readable code adapted to determine a number of users  $k_{21} = N_1$   
14 -  $k_{11}$  in the subset that did not select the item;  
15 computer-readable code adapted to determine a number of users  $k_{22} = N_2$   
16 -  $k_{12}$  not in the subset that did not select the item; and  
17 computer-readable code adapted to determine a log likelihood ratio for  
18 the item.

1           88. The computer-readable medium of claim 87, wherein the log likeli-  
2   hood ratio is defined as:

3           
$$\sum k_{ij} \log \frac{\pi_{ij}}{\mu_j}$$

4           where:  $\pi_{ij} = \frac{k_{ij}}{N_j}$ ,  $\mu_j = \sum_i \frac{k_{ij}}{N}$ .

1           89. The computer-readable medium of claim 59, wherein the computer-  
2   readable code adapted to determine the result by a log likelihood ratio analysis  
3   submethod further comprises:

4           computer-readable code adapted to adjust at least one of the  $n_{ij}$  values re-  
5           sponsive to at least one selected from the group consisting of:  
6           the number of occurrences of the item in a user log;  
7           the logarithm of the number of occurrences of the item in a user  
8           log;  
9           the number of occurrences of the item in all user logs;  
10          the logarithm of the total number of users divided by the number  
11          of users who have selected the item; and  
12          a normalizing factor.





7 defined as including those item groups that contain a second  
8 item;  
9 computer-readable code adapted to determine a number of item groups  
10  $N_2$  not in the subset of item groups;  
11 computer-readable code adapted to determine a number of item groups  
12  $k_{11}$  in the subset that contain the first item;  
13 computer-readable code adapted to determine a number of item groups  
14  $k_{12}$  not in the subset that contain the first item;  
15 computer-readable code adapted to determine a number of item groups  
16  $k_{21} = N_1 - k_{11}$  in the subset that do not contain the first item;  
17 computer-readable code adapted to determine a number of item groups  
18  $k_{22} = N_2 - k_{12}$  not in the subset that do not contain the first item;  
19 and  
20 computer-readable code adapted to determine a log likelihood ratio.

1 94. The computer-readable medium of claim 93, wherein the log likeli-  
2 hood ratio is defined as:

3 
$$\sum k_{ij} \log \frac{\pi_{ij}}{\mu_j}$$

4 where:  $\pi_{ij} = \frac{k_{ij}}{N_j}, \mu_j = \sum_i \frac{k_{ij}}{N}$ .

1           95. The computer-readable medium of claim 93, wherein each item group  
2 comprises a document.

1           96. The computer-readable medium of claim 93, further comprising:  
2 computer-readable code adapted to adjust at least one of the  $k_{ij}$  values re-  
3 sponsive to at least one selected from the group consisting of:  
4 the number of occurrences of the item in a document;  
5 the logarithm of the number of occurrences of the item in a docu-  
6 ment;  
7 the number of occurrences of the item in all documents;  
8 the logarithm of the total number of documents divided by the  
9 number of documents that include the item; and  
10 a normalizing factor.

1           97. The computer-readable medium of claim 96, wherein the normalizing  
2 factor is  $\frac{1}{\sqrt{\sum (S_j W_{ij})^2}}$ , where  $S_j$  represents the number of occurrences of the item  
3 in all documents and  $W_{ij}$  represents the number of occurrences of the item in a  
4 particular document.